Factors Affecting Farmland Values: Implications for Sector Wealth

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Abstract

The significance of farmland values to the agricultural balance sheet has increased steadily over time rising from 62% of agricultural assets in 1950 to 82% of the agricultural balance sheet in 2012. This study examines the relative significance of these changes in farmland values versus operating returns from agricultural assets in explaining changes in agricultural solvency over time. The results indicate that changes in farmland values explain 88.4% of the multiple correlation coefficient. However, this regression explains a relatively small share of the changes in sector solvency over time.

Key words: farmland values, solvency, regression information

JEL classification: Q14, C13

This paper examines the contribution of income, interest rates, and capital gains to farmland in determining changes in the farmer wealth using a panel approach to the information inequality (Moss 1997). Schmitz (1995) notes that farmland values are subject to boom/bust cycles. His findings indicate that farmland values are appropriately priced in the long-run, but exhibit systematic and sustained departures from this equilibrium in the short-run. Featherstone and Moss (2003) support the boom/bust cycle in farmland values using a stochastic trend model. They find that a large portion of the annual fluctuations in returns are transitory and do not contribute to fluctuations in farmland values. The linkage between returns and farmland values complicates agricultural policy raising the question of whether agricultural policy should target stabilizing farm income or wealth.

The significance of real estate to the equity of agriculture is well documented. In 1950, real estate represented 62% of all agricultural assets. By 1981, real estate had increased to 78% of all agricultural assets. In 1981, farm real estate values stood at $783 billion. By 1986, real estate had fallen to $542 billion or 69% of its 1981 value. Over the same time period machinery declined by $22 billion from $101 billion to $79 billion and investment in livestock and poultry declined by $6 billion, from $54 billion to $48 billion. Put slightly differently, 88% of the total decline in agricultural asset values between 1981 and 1986 was due to real estate compared with 2% from livestock and poultry investments, 8% from reductions in machinery investment, and 5% from reductions in crop inventories. From 1986 through 2012, total farm assets in the United States increased from $722 billion to $2,811 billion. Decomposing this increase, 82.2% of this increase resulted from real estate values compared with 1.2% from livestock investments and 8.2% of this increase has been in investments in machinery. Thus, the swings in the balance sheet can be traced to changes in farmland values.

Several studies note the significance of farmland values in determining farm equity. Shalit and Schmitz (1982) develop a model where farmers use farmland as a store of value allowing farmers access to credit. Lowenberg-DeBoer and Boehlje (1986) suggest that increases in commodity prices in the 1970s coupled with tax considerations generated incentives for farm expansion. These incentives caused capital gains to farmland which both increased the value of agricultural collateral and the demand for debt capital. The incidence of financial stress experienced by U.S. agriculture in the 1980s resulted from the combined effect of capital losses from falling commodity prices and financial risk resulting from the increased debt that farms took on to finance expansion. Lence and Miller (1999, p.257) state that ”boom-bust cycles in farmland prices have triggered noticeable wealth changes for the farm sector as a whole.” In their analysis of the Federal Agriculture Improvement and Reform Act of 1996, Lamb and Henderson (2000) link the potential impact of agricultural policy to farmland values primarily through subsidies on corn production.

They infer that these impacts could have dramatic consequences for the sector's solvency. de Fontnouvelle and Lence (2002, p.549) conjecture "Because land has become a major source of collateral in agricultural lending, large drops in land values have typically been accompanied by substantial reductions in the availability of credit to the sector."

We model the linkage between farmland values and solvency with the accounting identity

$$(1)\qquad E(t)+D(t)=L(t)\,p(t)+K(t)+C(t)$$

where $E(t)$ is equity, $D(t)$ is debt, $L(t)$ is the acres of farmland, $p(t)$ is the price of farmland, $K(t)$ is the level of intermediate assets, and $C(t)$ is the level of current assets at time t. Differentiating this equality yields

$$(2)\qquad dE(t)+dD(t)=dL(t)\,p(t)+L(t)\,dp(t)-\delta(t)\,K(t)+I(t)+dC(t)$$

where $dK(t)=-\delta(t)\,K(t)+I(t)$, $\delta(t)$ is the depreciation rate for intermediate assets, and $I(t)$ is the investment in new intermediate assets. We assume that intermediate assets are in steady state (or that $dK(t)=-\delta(t)\,K(t)+I(t)=0$). Thus,

$$(3)\qquad dE(t)=[dL(t)\,p(t)+L(t)\,dp(t)+dC(t)]-dD(t)$$

or the change in equity is determined by the change in the acres of farmland, changes in the price of farmland, changes in the level of current assets, and changes in the debt level. Defining the change in the current assets as the profit from operations less consumption

$$(4)\qquad dC(t)=r_o(t)\,[L(t)\,p(t)+K(t)+C(t)]-c(t)$$

where $r_o(t)$ is the operating rate of return on assets (i.e., the return not includeing capital gains) and $c(t)$ is consumption.

Substituting Equation 4 into Equation 3 completes the relationship between changes in farmland values and farm equity. Given that additional capital attracted to the farm sector has been largely from additional debt (Featherstone et al. 2005) changes in equity are determined by changes in the right-hand side of Equation 3 (or causality can be assumed). Consumption must be supported from operating returns or increases in the level of debt since $C(t)$ must be chosen such that $C(t) \geq 0$. Mathematically,

$$c(t) \leq dD(t) + r_o(t)\left[L(t)\,p(t) + K(t) + C(t)\right] \ni: C(t) \geq 0 \tag{5}$$

in essence capital gains cannot be directly consumed, but must be converted into increased debt. The change in debt is an endogenous variable that can be modeled using a variety of models. Ramirez, Moss, and Boggess (1997) derive an optimal debt formulation where debt is a function of the expected rate of return on agricultural assets (i.e., including both $\mu_0(t) = \mathrm{E}\left[r_0(t)\right]$ and the capital gains), the riskiness of returns, and risk aversion. Alternatively, we could model the change in debt as externally rationed because of credit market failures such as asymmetric information along the lines of Stiglitz and Weiss (1981). For the purposes of this study we will focus on the linkage between farmland values and equity. Specifically, given that the total quantity of farmland in U.S. agriculture is relatively constant over time, changes in farm equity are primarily affected by changes in farmland prices.

An Empirical Model of Real Asset Values and Solvency

We begin our derivation of an empirical model linking equity to real estate prices with the accounting identity in Equation 1 and divide by total assets

$$(6) \quad 1=\frac{E(t)}{A(t)}+\frac{D(t)}{A(t)}=\frac{L(t)\,p(t)}{A(t)}+\frac{K(t)}{A(t)}+\frac{C(t)}{A(t)}$$

Given this identity, we focus on with the debt-to-asset ratio. Changing from continuous time notation to a discrete time subscript and differentiating Equation 6 yields

$$(7) \quad \Delta\left(\frac{D}{A}\right)_t=1-\Delta\left(\frac{Lp}{A}\right)_t-\Delta\left(\frac{K}{A}\right)_t-\Delta\left(\frac{C}{A}\right)_t$$

By our preceding discussion the change in the second term on the right-hand-side of Equation 7 is dominated by changes in farmland values (or the rate of capital gain) since changes in aggregate farmland levels are fairly small. Equating investment and depreciation on intermediate assets, the third term becomes a small error term, and following Equation 5 we replace the fourth term with

$$(8) \quad \Delta\left(\frac{C}{A}\right)_t=\alpha_1 r_{ot}+\alpha_2 i_t+\varepsilon_t$$

where r_{0t} is the operating return on agricultural assets without deducting for interest charges, i_t is the interest rate on agricultural debt and ε_t is an error term. Defining the rate of capital gains as ΔLp and substituting the result from Equation 8 into Equation 7 yields

$$(9) \quad \Delta_t\left(\frac{D}{A}\right)=\beta_0+\beta_1\Delta_t(Lp)+\beta_2 r_{o,t-1}+\beta_3 i_{t-1}+\nu_t$$

where $\Delta_t(D/A)$ is the logarithmic change in the debt-to-asset ratio, $\Delta_t(Lp)$ is the logarithmic change in the value of real estate, ν_t is a residual and the βs are estimated parameters.

The change in solvency will be allocated between capital gains on real estate, income to assets and the cost of debt.

To examine the linkage between farmland values and the debt-to-asset ratio, we apply the information approach used by Moss (1997) based on Theil's (1987) bits of information approach to the balance sheet and income statement data of Mishra, Moss, and Erickson (2008). Theil notes that the multiple correlation coefficient of the regression can be expressed as the product of partial correlation coefficients between the dependent variable and the independent variables

$$(10) \quad \left(1-R^2\right) = \left(1-r_{01}^2\right)\left(1-r_{02\cdot 1}^2\right)\left(1-r_{03\cdot 12}^2\right)$$

where $r_{02\cdot 1}^2$ is the partial correlation coefficient between the dependent variable and the second independent variable after the correlation between the independent variable and the first independent variable and the first and second independent variables have been removed (Anderson 1984). Given that there are several possible orderings for the independent variables for each regression, Theil suggests that the explanatory power of each regression coefficient can be measured by the average of the possible orderings of the partial correlations.

Empirical Results

In all cases, increases in farmland values are associated with a reduction in each state's debt-to-asset ratio, or increases in the state's solvency. In 37 states, increases in the return on assets reduce the debt-to-asset ratio (or an increase in that state's solvency). However, in 11 states (Alabama, Arkansas, California, Colorado, Florida, Georgia, Kentucky, Mississippi, New Mexico, North Carolina, and Texas) increases in return on agricultural assets imply higher debt-to-asset ratios. In all but 12 states (Iowa, Michigan, Minnesota, New Hampshire, New Jersey, North Carolina, North Dakota, Oklahoma, Oregon, South

Carolina, Rhode Island, and Wisconsin) increases in the interest rate reduces the state's debt-to-asset ratio.

States with an information measure of greater than 0.415 (which implies an $\bar{r}_i^2$ of 25% [1]) include Arizona, Arkansas, Colorado, Connecticut, Florida, Illinois, Indiana, Iowa, Kansas, Maryland, Michigan, Minnesota, Missouri, Nebraska, New Jersey, New Mexico, Ohio, Pennsylvania, Texas, Utah, and Wisconsin. Illinois's information measure implies a of 46.2%, Iowa's information measure implies a of 48.4%, Arizona's information measure implies a of 82.0%, and New Mexico's information measure implies a of 55.5 percent.

In 31 states (or almost 65% of the contiguous states) real estate contributes more information than either returns to agricultural assets or the interest rate with an information index of greater than 0.20 including Arkansas, Arizona, California, Colorado, Connecticut, Florida, Idaho, Illinois, Indiana, Iowa, Kansas, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Nebraska, Nevada, New Hampshire, New Jersey, New Mexico, North Dakota, Ohio, Pennsylvania, Texas, Utah, Virginia, West Virginia, Washington, Wisconsin, and Wyoming. In six additional states, real estate contributes the most information, but the total bits of information is less than 0.20: Delaware, Maine, Mississippi, Rhode Island, South Dakota, and Vermont. Only in ten states (Georgia, Kentucky, Louisiana, Montana, New York, North Carolina, Oklahoma, Oregon, South Carolina, and Tennessee) does information on returns to agricultural assets contribute relatively more information than real estate. Further, the informational content of returns on agricultural assets is higher than 0.20 for only Georgia, Kentucky, Montana, Oklahoma, Oregon, South Carolina, and Tennessee. Interest rates only dominate the other regressors for Alabama where the informational content of all variables is less than 0.20.

Table 2 presents the informational results for the fixed effects panel specifications. We see that real estate contributes the greatest amount of information in each regression with the exception of the southern plains where return on assets contributes more information. Apart from the overall results, changes in real estate values contain the most information in the Lake States, Corn Belt, and Mountain states. In no region do changes in real estate values explain the majority of the variation in farm solvency. In the Mountain States, changes in real estate values account for 42.7% of the overall variation of changes in solvency. Aggregating over all states, changes in real estate account for 0.328 of the 0.371 bits of information generated by the regression (or 88 percent of the information in the overall regression). However, overall this implies that changes in real estate values account for only 20.3% of the overall variation in the sector's solvency.

Conclusions

This study examined the role of agricultural real estate values in determining the solvency of the sector. The results indicated that the informational content of farmland values in explaining solvency across states was high with farmland values contributing 88% of the information in the regressions on average. However, this represents an anemic 20.3% of the overall variation in the debt-to-asset position over time. Regionally, changes in real estate values explain more of the variation in solvency in the Lake States, Corn Belt, and Mountain States. Among these states, the experience of the Lake States and Corn Belt would be consistent with farmers' experiences during the period of stress during the 1980s. Further supporting this contention is the result that the linkage between changes in real estate values and solvency were particularly pronounced in Iowa (which was particularly affected by this period of financial stress).

Our empirical results support the contention that farm wealth is driven by farmland values, or at least that changes in returns and interest rates contain significantly less information on changes in wealth. The question of determining factors that drive farmland values then returns to a central point in the agricultural policy debate which is particularly troublesome given the boom/bust tendencies of farmland values.

Notes

[1]Reversing the derivation of an information measure

$$
\begin{aligned}
\bar{I}(r) &= -\log_2\left(1-\bar{r}_i^2\right) \\
1-\bar{r}_i^2 &= 2^{-\bar{I}(r)} \qquad (11) \\
\bar{r}_i^2 &= 1-2^{-\bar{I}(r)}
\end{aligned}
$$

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Table 1. State Level Effect of Changes in Land Values, Returns and Interest Rates on Solvency

	Regression Results				Total	Bits of Information		
State	Constant	Real Estate	Returns on Assets	Interest Rate	bits of Information	Real Estate	Returns on Assets	Interest Rate
				Northeast				
Connecticut	0.210	-1.161	-0.093	-2.351	0.606	0.416	0.062	0.128
	(0.052)[a]	(0.284)	(0.102)	(1.339)				
Delaware	0.055	-0.283	-0.042	-0.559	0.091	0.078	0.007	0.006
	(0.045)	(0.187)	(0.164)	(1.651)				
Maine	0.212	-0.527	0.220	-4.120	0.471	0.160	0.042	0.269
	(0.054)	(0.185)	(0.356)	(1.296)				
Maryland	0.132	-0.599	-0.075	-2.711	0.831	0.690	0.050	0.090
	(0.041)	(0.112)	(0.138)	(1.671)				
Massachusetts	0.137	-0.807	-0.151	-0.957	0.345	0.218	0.057	0.069
	(0.048)	(0.308)	(0.179)	(1.231)				
New Hampshire	0.031	-0.599	-1.105	2.567	0.484	0.304	0.104	0.076
	(0.065)	(0.196)	(0.469)	(1.909)				
New Jersey	0.089	-0.818	-0.263	0.490	0.580	0.481	0.071	0.028
	(0.076)	(0.200)	(0.204)	(3.690)				
New York	0.068	-0.248	-0.530	-0.005	0.278	0.092	0.168	0.018
	(0.037)	(0.123)	(0.225)	(0.721)				
Pennsylvania	0.184	-0.533	-0.153	-3.551	1.203	0.783	0.120	0.301
	(0.036)	(0.083)	(0.129)	(1.149)				
Rhode Island	0.033	-0.592	-0.165	1.756	0.126	0.074	0.045	0.008
	(0.133)	(0.404)	(0.129)	(3.415)				
Vermont	0.065	-0.431	-0.387	-0.037	0.238	0.150	0.073	0.015
	(0.076)	(0.187)	(0.227)	(2.016)				
				Lake States				
Michigan	0.105	-0.510	-1.094	0.210	0.814	0.495	0.225	0.094
	(0.053)	(0.111)	(0.480)	(1.984)				
Minnesota	-0.004	-0.371	-1.673	3.303	1.193	0.733	0.307	0.153
	(0.053)	(0.081)	(0.475)	(1.680)				
Wisconsin	0.019	-0.329	-1.157	2.596	0.911	0.461	0.331	0.118
	(0.041)	(0.079)	(0.321)	(1.434)				
				Corn Belt				
Illinois	0.130	-0.534	-0.244	-2.058	0.995	0.895	0.040	0.061
	(0.062)	(0.092)	(0.361)	(1.958)				
Indiana	0.101	-0.380	-0.325	-1.446	0.583	0.476	0.067	0.040
	(0.054)	(0.098)	(0.331)	(1.814)				
Iowa	0.083	-0.543	-0.570	0.008	1.145	0.955	0.103	0.087
	(0.051)	(0.097)	(0.343)	(1.633)				
Missouri	0.076	-0.425	-1.015	-0.288	0.547	0.425	0.073	0.049
	(0.060)	(0.122)	(0.677)	(1.702)				
Ohio	0.108	-0.411	-0.256	-1.708	0.559	0.454	0.058	0.048
	(0.052)	(0.104)	(0.277)	(1.565)				
				Northern Plains				
Kansas	0.093	-0.453	-1.215	-0.481	0.802	0.589	0.145	0.068
	(0.044)	(0.102)	(0.772)	(1.233)				
Nebraska	0.092	-0.552	-1.281	-0.021	1.102	0.861	0.179	0.062
	(0.044)	(0.095)	(0.509)	(1.061)				
North Dakota	0.019	-0.220	-2.212	1.223	0.418	0.201	0.163	0.054
	(0.046)	(0.098)	(0.877)	(1.013)				
South Dakota	0.147	-0.475	-1.969	-1.175	0.337	0.190	0.109	0.038
	(0.068)	(0.186)	(1.324)	(1.470)				
				Appalachia				
Kentucky	0.071	-0.166	-0.498	-0.520	0.268	0.026	0.232	0.010
	(0.042)	(0.135)	(0.183)	(0.866)				
North Carolina	0.030	-0.035	-0.127	0.059	0.087	0.002	0.080	0.006
	(0.056)	(0.138)	(0.090)	(1.316)				
Tennessee	0.084	-0.165	-1.101	-0.520	0.476	0.027	0.417	0.032
	(0.043)	(0.149)	(0.309)	(0.791)				
Virginia	0.154	-0.461	-0.550	-2.608	0.776	0.350	0.259	0.167
	(0.038)	(0.107)	(0.175)	(0.998)				
West Virginia	0.235	-0.746	-3.115	-4.314	1.217	0.763	0.387	0.067
	(0.078)	(0.117)	(0.640)	(2.479)				

Continued on the next page.

Table 1. State Level Effect of Changes in Land Values, Returns and Interest Rates on Solvency

	Regression Results				Total	Bits of Information		
State	Constant	Real Estate	Returns on Assets	Interest Rate	bits of Information	Real Estate	Returns on Assets	Interest Rate
				Southeast				
Alabama	0.071	-0.181	-0.045	-1.397	0.078	0.020	0.020	0.037
	(0.059)	(0.185)	(0.224)	(1.432)				
Florida	0.142	-0.553	-0.176	-2.710	0.725	0.499	0.147	0.078
	(0.049)	(0.120)	(0.081)	(1.959)				
Georgia	0.163	-0.451	-0.279	-2.549	0.481	0.133	0.214	0.134
	(0.055)	(0.174)	(0.127)	(1.181)				
South Carolina	0.043	-0.264	-0.684	0.706	0.177	0.047	0.118	0.012
	(0.080)	(0.224)	(0.343)	(1.812)				
				Delta States				
Arkansas	0.105	-0.471	-0.127	-1.607	0.501	0.430	0.017	0.054
	(0.050)	(0.124)	(0.189)	(1.204)				
Louisiana	0.106	-0.295	-0.798	-0.681	0.269	0.114	0.122	0.034
	(0.053)	(0.145)	(0.486)	(1.374)				
Mississippi	0.101	-0.303	-0.331	-1.265	0.238	0.147	0.050	0.041
	(0.045)	(0.128)	(0.298)	(0.985)				
				Southern Plains				
Oklahoma	0.012	-0.233	-2.072	1.271	0.558	0.186	0.291	0.081
	(0.034)	(0.095)	(0.561)	(0.798)				
Texas	0.105	-0.436	-0.394	-1.657	0.671	0.457	0.036	0.178
	(0.027)	(0.098)	(0.523)	(0.614)				
				Mountain States				
Arizona	0.122	-0.828	-1.424	-1.180	2.692	2.472	0.121	0.099
	(0.033)	(0.061)	(0.910)	(0.706)				
Colorado	0.184	-0.567	-0.456	-3.498	0.793	0.549	0.038	0.206
	(0.047)	(0.114)	(0.794)	(1.189)				
Idaho	0.057	-0.428	-0.526	-0.077	0.509	0.400	0.088	0.022
	(0.049)	(0.120)	(0.315)	(1.318)				
Montana	0.104	-0.313	-7.225	-0.551	0.555	0.193	0.352	0.010
	(0.056)	(0.119)	(2.060)	(1.349)				
Nevada	0.072	-0.515	-0.715	-1.962	0.336	0.315	0.005	0.015
	(0.068)	(0.165)	(3.019)	(2.796)				
New Mexico	0.147	-0.711	-0.442	-3.009	1.313	1.169	0.017	0.128
	(0.042)	(0.096)	(1.597)	(1.160)				
Utah	0.109	-0.500	-2.134	-1.262	1.039	0.810	0.207	0.022
	(0.057)	(0.085)	(0.701)	(1.246)				
Wyoming	0.095	-0.382	-2.470	-1.589	0.312	0.241	0.026	0.044
	(0.052)	(0.134)	(3.904)	(1.126)				
				Pacific				
California	0.080	-0.312	-0.111	-0.993	0.586	0.356	0.109	0.121
	(0.025)	(0.090)	(0.096)	(0.755)				
Oregon	-0.043	-0.246	-2.564	4.138	0.808	0.179	0.484	0.145
	(0.058)	(0.125)	(0.542)	(1.859)				
Washington	0.080	-0.366	-0.557	-0.510	0.524	0.341	0.133	0.050
	(0.045)	(0.103)	(0.330)	(1.412)				

Tables

Table 2. Informational Results for the Fixed Effect Panel Specification

	Regression Results			Total	Bits of Information		
Region	Real Estate	Returns on Assets	Interest Rate	bits of Information	Real Estate	Returns on Assets	Interest Rate
Northeastern	-0.516	-0.110	-1.316	0.233	0.172	0.032	0.029
	(0.062)a	(0.040)	(0.442)				
Lake States	-0.396	-1.251	2.095	0.938	0.573	0.273	0.092
	(0.049)	(0.227)	(0.936)				
Corn Belt	-0.470	-0.382	-1.092	0.757	0.646	0.060	0.050
	(0.044)	(0.149)	(0.725)				
Northern Plains	-0.428	-1.367	-0.300	0.488	0.358	0.103	0.026
	(0.061)	(0.392)	(0.600)				
Appalachia	-0.262	-0.242	-1.120	0.214	0.096	0.091	0.026
	(0.059)	(0.064)	(0.507)				
Southeast	-0.369	-0.210	-1.726	0.238	0.103	0.088	0.047
	(0.086)	(0.069)	(0.662)				
Delta	-0.355	-0.273	-1.451	0.265	0.187	0.038	0.040
	(0.076)	(0.163)	(0.643)				
Southern Plains	-0.216	-1.291	0.062	0.433	0.078	0.341	0.014
	(0.082)	(0.258)	(0.536)				
Mountain	-0.607	-0.719	-2.005	0.906	0.804	0.037	0.065
	(0.036)	(0.252)	(0.409)				
Pacific	-0.310	-0.216	-0.724	0.371	0.252	0.087	0.033
	(0.061)	(0.096)	(0.643)				
All States	-0.462	-0.1482	-1.636	0.371	0.328	0.036	0.043
	(0.019)	(0.024)	(0.172)				